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Indian Standard

SPECIFICATION FOR BALLASTS FOR FLUORESCENT LAMPS

PART I FOR SWITCH START CIRCUITS

(*Second Revision*)

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Indian Standard

SPECIFICATION FOR BALLASTS FOR FLUORESCENT LAMPS

PART I FOR SWITCH START CIRCUITS

(Second Revision)

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Indian Standard

SPECIFICATION FOR
BALLASTS FOR FLUORESCENT LAMPS

PART I FOR SWITCH START CIRCUITS

(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Part I) (Second Revision) was adopted by the Indian Standards Institution on 4 November 1977, after the draft finalized by the Electric Lamps and Accessories Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard was first published in 1960, and has been revised to line up with the second edition of IEC Publication No. 82 ' Recommendation for ballasts for fluorescent lamps ' issued in 1962 and its Amendment No. 1 published in 1965. This revision (Second Revision) has been taken to line up with IEC Pub No. 82 (1973) Ballasts for tubular fluorescent lamps published by the International Electrotechnical Commission.

0.3 The need for limiting the ballast noise and also for providing for radio interference suppression is generally recognized but owing to insufficient data being available, it has not been possible to include in this revision the requirements and tests on these aspects.

0.4 In order to obtain satisfactory performance of fluorescent lamps and their associated ballasts, it is necessary that certain features of their designs be properly co-ordinated. It is essential, therefore, that specifications for them be written in terms of measurements made against some common basis, which must be reasonably permanent and reproducible.

0.4.1 These conditions may be fulfilled by special inductive-type ballasts which are called 'reference ballasts'. These ballasts are used for the testing of ordinary ballasts and for the selection of reference lamps.

0.4.2 Moreover, the testing of ballasts for fluorescent lamps presents particular difficulties which require a proper definition of testing methods. This testing will, in general, be made with reference lamps and, in particular, by comparing results obtained on such a lamp with the ballast to be tested and with the reference ballast.

0.4.3 The specification describes the requirements with which ballasts shall comply in order to ensure the correct performance of complete fluorescent lamp circuits. It includes, in addition, all those features of reference ballast construction and performance which are considered necessary to ensure accurate and reproducible results when testing the ballasts, particularly with regard to the selection of reference lamps.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS: 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part I) describes the requirements to ensure correct performance of ballasts when used with tubular fluorescent lamps [*see* IS: 2418 (Part I)-1977 and IS: 2418 (Part II)-1977†] of rated wattages 20, 40, 65 and 80 with preheated cathodes when used in switch start circuits.

1.1.1 This standard covers ballasts excluding the resistance types for use on ac supply up to 250 V at 50 Hz.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Ballast — A ballast is a unit inserted between the supply and one or more discharge lamps, which by means of inductance, capacitance or resistance, singly or in combination, serves mainly to limit the current of the lamp or lamps to the required value.

It may also include means for transforming the supply voltage and arrangements which help to provide starting voltage and pre-heating current, prevent cold starting, reduce stroboscopic effect, correct the power factor and suppress radio interference:

a) *Independent Ballast* — A ballast consisting of one or more separate elements so designed that it, or they, can be mounted separately outside a lighting fitting and without any additional enclosure.

b) *Built-in Ballast* — A ballast exclusively designed to be built into a lighting fitting, or box, an enclosure or the like.

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*Rules for rounding off numerical values (*revised*).

†Specification for tubular fluorescent lamps for general lighting service:
Part I Requirements and tests (*first revision*).
Part II Standard lamp data sheets (*first revision*).

2.2 Reference Ballast (**RB**) — A special inductive-type ballast designed for the purpose of providing comparison standards for use in testing ballasts and for the selection of reference lamps; it is essentially characterized by a stable voltage to current ratio, which is relatively uninfluenced by variations in current, temperature and the magnetic surroundings, as outlined in this specification (*see* Appendix A).

2.3 Reference Lamp — A lamp selected for testing ballasts which, when associated with a reference ballast under the conditions specified in this standard (*see* Appendices A and B), has electrical characteristics which are close to the values given in IS : 2418 (Part I)-1977 and IS : 2418 (Part II)-1977* within the limits defined in Appendix B.

2.4 Calibration Current of a Reference Ballast — The value of the current on which are based the calibration and control of the ballast.

NOTE — Such a current should always be approximately equal to the running current of the lamps for which the reference ballast is suitable.

2.5 Supply Voltage — The voltage applied to the complete circuit of lamp or lamps and ballast.

2.6 Supply Current — The current supplied to the complete circuit of lamp or lamps and ballast.

2.7 Overall Power Factor (Symbol λ) — The power factor of the combination of a ballast and the lamp or lamps for which the ballast is designed.

2.8 High Power Factor Ballast — A ballast having an overall power factor of at least 0·85.

NOTE — The value of 0·85 takes into account the effect on the power factor of the distortion of the current waveform.

2.9 Normal Operation — Lamp connected to the ballast under test should be on for 15 minutes at rated supply voltage.

2.10 Rated Maximum Operating Temperature of a Capacitor — The highest permissible temperature which may occur at any place on the outer surface of the capacitor to ensure sufficient life.

2.11 Rated Maximum Operating Temperature of a Ballast Winding (Symbol t_w) — The highest temperature of a ballast winding which gives an expectancy of ten years continuous service (at that temperature).

2.12 Rated Temperature-Rise of a Ballast Winding (Symbol $\triangle t$) — The declared temperature-rise of the winding when the ballast is tested under the conditions specified in this standard.

NOTE 1 — The specifications for the supply and mounting conditions of the ballast are given in **9.9** and Appendix C.

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*Specification for tubular fluorescent lamps for general lighting service:
Part I Requirements and tests (*first revision*).
Part II Standard lamp data sheets (*first revision*).

NOTE 2 — They apply to built-in ballasts only and, therefore, the very concept of rated temperature rise is applicable only, for the time being, to such ballasts.

2.13 Working Voltage — The highest rms voltage which may occur across any insulation, transients being neglected, in open circuit conditions or during lamp operation.

2.14 Parallel Cathode Heating (or Pre-heating) — Type of heating (or pre-heating) supplied by a low tension winding of the ballast directly connected to the cathode terminations of the lamp.

NOTE — This type of heating circuit is only used in practice with lamps operated without starters.

2.15 Series Cathode Heating (or Pre-heating) — Type of heating (or pre-heating) in which a cathode is connected in series in the main circuit, before the lamp has started.

2.16 Rectifying Effect — The effect which may occur at the end of lamp life when one cathode is either broken or has insufficient electron emission resulting in the arc current in consecutive half-cycles being unequal.

2.17 Type Tests — Tests carried out to prove conformity with this standard. These are intended to prove the general qualities and design of a given type of ballast.

2.18 Acceptance Tests — Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

2.19 Routine Tests — Tests carried out on all ballasts to check requirements which are likely to vary during production.

3. GENERAL DESIGN, CONSTRUCTION AND WORKMANSHIP

3.1 General

3.1.1 Ballasts shall be so designed and constructed that in normal use their performance is reliable and without danger to the user or surroundings.

3.1.2 Ballasts shall be mechanically robust. They shall be so designed and constructed as to withstand the change of temperature and moisture in the surrounding.

3.1.3 All exposed metal parts shall either be constructed of non-ferrous material or adequately protected against corrosion.

3.1.4 Adequate robust means of fixing shall be provided to ensure satisfactory mechanical and thermal contact with the surface on which they are mounted.

3.1.5 Independent ballasts shall be so designed that a distance in air of at least 5 mm is provided between a flat supporting surface and parts liable to be overheated in the event of a fault, such as winding, iron core and resistors.

Compliance is checked by measurement.

NOTE — The required distance in air may be provided on either side of a ballast enclosure, if any, or it may be divided by this enclosure.

4. TERMINALS FOR EXTERNAL WIRING

4.1 When terminals are provided for wiring, they shall comply with the following requirements.

4.1.1 Terminals shall permit the connection of conductors with cross sectional area as given in Table 1.

TABLE 1 CROSS SECTIONAL AREA OF TERMINALS

TERMINALS FOR CONNECTION (1)	CROSS SECTIONAL AREA (2) mm^2
Terminals for supply wire	0·75 to 2·5
Terminals for other external wires	0·75 to 1·5

4.1.2 Screw terminals shall be so fixed that when the clamping means are tightened or loosened, they will not work loose; internal conductors are not subjected to stress and creepage distances and clearances are not reduced below the values specified in **7**.

4.1.3 Screw terminals shall be so designed that provision is made for the conductor to be clamped between two metal surfaces and that they allow connection to be made with sufficient contact pressure without damage to the conductor. A conductor shall be considered to be damaged if it shows deep incisions or shearing.

4.1.4 Any screw terminals for external wiring shall be so placed that when the connection of the conductors is correctly made, there is no risk of accidental contact between live parts of opposite polarity or between live parts and accessible metal parts.

4.1.5 All external screw terminals shall be so located that the wires can easily be introduced and connected and so that the cover, if any, can be fixed without risk of damage to the wires.

4.1.6 Screwless terminals, when used shall conform to IS : 6585-1972*.

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*Specification for screwless terminals and electrical connections for lighting fittings.

5. SCREWS, CURRENT-CARRYING PARTS AND CONNECTIONS

5.1 Screwed connections, electrical or otherwise, the failure of which might cause the ballast to become unsafe, shall withstand the mechanical stresses occurring in normal use.

5.1.1 Screws transmitting contact pressure and screws which are operated when mounting or connecting the ballast shall have a nominal diameter less than 3 mm.

5.1.2 Compliance is checked by inspection and, for screws and nuts transmitting contact pressure, or which are operated when mounting or connecting the ballast, as per test described in Appendix C.

5.2 Screws in engagement with a thread of insulating materials shall have a length of engagement of at least 3 mm plus one-third of the nominal screws diameter, except that this length need not exceed 8 mm. Correct introduction of the screw into the screw hole or nut shall be ensured. Compliance is checked by inspection, by measurement and by manual test.

5.2.1 The requirement with regard to correct introduction is met if introduction of the screw in a slanting manner is prevented, for example, by guiding the screw by the part to be fixed, by a recess in the female thread or by the use of a screw with the leading thread removed.

5.3 Electrical connections shall be so designed that contact pressure is not transmitted through the insulating material other than ceramic, pure mica or other material with characteristics no less suitable, unless there is sufficient resiliency in the metal parts to compensate for any possible shrinkage of the insulating materials. Compliance is checked by inspection.

5.4 Self-tapping screws shall not be used for the connection of current-carrying parts.

5.4.1 Self-tapping screws may be used to provide earthing continuity, provided that it is not necessary to disturb the connection in normal use and at least two screws are used for each connection.

5.4.2 Compliance is checked by inspection.

5.5 Screws and rivets which serve as electrical as well as mechanical connections shall be locked against loosening. Compliance is checked by inspection and by manual test. Spring washers may provide satisfactory locking.

5.5.1 For rivets, a non-circular shank or an appropriate notch may be sufficient.

5.5.2 Sealing compound which softens on heating provides satisfactory locking only for screw connections not subject to torsion in normal use.

5.6 Current-carrying parts shall be of copper aluminium, an alloy containing at least 50 percent copper, or other metal, no less resistant to corrosion than copper and having mechanical properties no less suitable.

5.6.1 Compliance is checked by inspection and by chemical analysis.

5.6.2 The requirement does not apply to screws which do not essentially carry current, such as terminal screws.

6. PROVISION FOR EARTHING

6.1 The earthing terminal, if any, shall be of a type in which the conductor is secured by means of a screw, which shall not work loose in normal use; it shall be placed near to the main terminals and shall be clearly and indelibly marked with the symbol '⏚' This symbol shall not be placed on screws, removable washers or other easily removable parts.

6.2 The earthing terminal shall comply with the requirements of **4** and **5**.

6.3 The metal of the earthing terminal shall be such that there is no danger of bi-metallic corrosion resulting from contact with the earthing conductor.

6.4 The screws or the other parts of the earthing terminal shall be made of brass or other non-rusting conducting metal, and all the contact surfaces shall be of bare metal.

6.5 It shall not be possible to loosen the earthing terminal screw without the aid of a tool.

7. CREEPAGE DISTANCES AND CLEARANCES

7.1 Creepage distances and clearances shall not be less than the values given in Table 2.

8. MARKING

8.1 Ballast Marking — Ballasts shall be marked legibly and durably giving the following information:

a) Mark of origin (this may take the form of a trade-mark, or the manufacturer's name or the name of the responsible vendor);

b) Type;

c) Wiring diagram indicating clearly the position of terminals, unless connections are self-evident;

NOTE 1 — In the case of built-in ballasts having no terminals, a clear indication shall be given on the wiring diagram of the significance of the code used for the connecting wires.

NOTE 2 — In the case of a ballast using a capacitor, the repetition on the ballast of the rated voltage, capacitance and, if necessary, the rated operating temperature of the capacitor is recommended.

d) Rated lamp voltage(s), frequency and lamp current(s);

e) Rated wattage and if necessary, the designation of the type(s) of lamp for which the ballast is designed. If the ballast is to be used with more than one lamp, the number and wattage of each lamp is to be indicated;

f) Power factor;

NOTE — If the power factor is less than 0·95 leading, it shall be followed by the letter 'C'.

g) Ballasts with a rated maximum operating temperature of the winding shall be marked with the claimed value following the symbol t_w, values increasing in 5°C steps;

NOTE — Preferred values of rated maximum operating temperature are the following:

90°, 105°, and 120°C

h) Ballast with t_w marking may also be marked with the rated temperature-rise of the windings following the symbol $\triangle t$;

NOTE — Preferred values of rated temperature rise are the following:

55°, 70°, and 85°C

j) Country of manufacture.

8.1.1 The ballasts may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

8.2 Compliance for durability and eligibility shall be checked by inspection and by trying to remove the marking by rubbing lightly, for 15 seconds, with a piece of cloth soaked in water.

NOTE — Capacitors, when used externally or as part of the ballast (as in the case of capacitor-type ballast), for power factor improvement as well as for radio interference suppression shall comply with the requirements of IS : 1569-1963*.

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*Specification for capacitors for electric discharge lamps (fluorescent and mercury vapour).

9. TESTS

9.0 General — Unless otherwise specified, ballast performance tests shall be carried out under prevailing atmospheric conditions or under conditions specified in Appendix D.

TABLE 2 CREEPAGE DISTANCES AND CLEARANCES

(*Clause* 7.1)

	Working Voltage	
	Up to and Including 24V mm	Above 24V Up to and Including 250V mm
(1)	(2)	(3)
Creepage Distance		
i) Between live parts of different polarity	2	3 (2)*
ii) Between live parts and accessible metal parts which are permanently fixed to the auxiliary, including screws or devices for fixing covers or fixing the auxiliary to its support	2	4 (2)*
Clearance		
iii) Between live parts of different polarity	2	3 (2)*
iv) Between live parts and accessible metal parts which are permanently fixed to the auxiliary, including screws or devices for fixing covers or fixing the auxiliary to its support	2	4 (2)*
v) Between live parts and a flat supporting surface or a loose metal cover, if any, if the construction does not ensure that the values under (iv) above are maintained under the most unfavourable conditions	2	6

*The values given in parentheses apply to creepage distances and clearances completely protected against dirt. Completely sealed-off or compound-filled distances are not checked.

The contribution to the creepage distances or any groove less than 1 mm wide is limited to its width.

Any air gap less than 1 mm is ignored in computing the total air path.

A metal enclosure shall have an insulating lining if, in the absence of such lining, a creepage distance or clearance between live parts and the enclosure would be smaller than the values prescribed above.

9.1 Type Tests

9.1.1 The manufacturer shall submit to the testing authority not less than 12 samples of ballasts, preferably selected at random from regular production lots, together with relevant technical data as required.

9.1.1.1 On five samples out of twelve all the type tests (except thermal endurance) shall be conducted in the sequence given in **9.1.4.** On the next seven samples test for checking thermal endurance of winding shall be conducted.

9.1.2 *Criteria for Approval* — The testing authority shall issue a type approval certificate, if the ballasts are found to comply with the requirements of the test. In case of failure in any test, testing authority shall call for fresh samples not exceeding twice the number of original samples and subject them to all the tests. If in repeat tests, no failure occurs, the tests may be considered to have been satisfied.

9.1.3 Any changes in design, construction, manufacturing process or material used in a ballast of approved type, shall be brought to the notice of the authority who may, at its discretion, call for fresh samples embodying these changes.

9.1.4 The following tests shall constitute type tests and shall be carried out on all samples in the sequence given:

a) Visual examination (*see* **9.4**),
b) Test for terminals for external wiring (*see* **4**),
c) Test for screws, current-carrying parts and connections (*see* **5**),
d) Testing of provision for earthing (*see* **6**),
e) Test for creepage distance and clearance (*see* **7**),
f) Protection against accidental contacts and electric shock (*see* **9.5**),
g) Voltage across capacitors (*see* **9.6**),
h) Test for moisture resistance and insulation (*see* **9.7**),
j) Test for thermal endurance of windings (*see* **9.8**),
k) Test for limitations of ballast heating (*see* **9.9**),
m) Test for mechanical strength of independent ballasts (*see* **9.10**),
n) Test for resistance to heat (*see* **9.11**),
p) Resistance to corrosion (*see* **9.12**), and
q) Testing of performance (*see* **9.13**).

9.2 Acceptance Tests — The following shall constitute acceptance tests to be carried out on the samples selected at random from each lot:

a) Visual examination (*see* **9.4**),

b) Insulation resistance (dry) test (*see* **9.7.1**),
c) High voltage test (*see* **9.7.4**),
d) Preheating conditions (*see* **9.13.3**), and
e) Power output (*see* **9.13.4**).

9.2.1 The sampling procedure and criteria of acceptance shall be subject to agreement between the supplier and the purchaser. In the absence of such an agreement, the sampling procedure detailed in Appendix E may be followed.

9.3 Routine Tests — The following tests shall be carried out on all ballasts in the order given below:

a) Visual examination (*see* **9.4**),
b) High voltage test (*see* **9.7.4**), and
c) Preheating conditions (*see* **9.13.3**).

9.4 Visual Examination — Ballasts shall not have any visible sign of damage. Compliance is checked by visual examination.

9.5 Protection Against Accidental Contacts and Electric Shock

9.5.1 *Protection Against Accidental Contact*

9.5.1.1 Independent ballast shall be so constructed and enclosed that they are sufficiently protected against accidental contact with live parts when installed as in normal use.

9.5.1.2 The enclosures of independent ballasts shall have no opening giving access to live parts other than those necessary for use and working.

NOTE — Lacquer or enamel is not deemed to be adequate protection or insulation for the purpose of this requirement.

9.5.1.3 Parts providing protection against live parts shall have adequate mechanical strength and shall not work loose in normal use. It shall not be possible to remove them without the aid of a tool.

Compliance is checked by inspection, and by means of a test finger (*see* IS : 1401-1970*) using an electrical indicator to show contact. This finger is applied in all possible positions, if necessary, with a force of 30 N.

9.5.2 *Protection Against Electric Shock*

9.5.2.1 Ballasts in which a capacitor is enclosed with a capacity exceeding 0·5 µF shall be provided with an adequate discharge device so that the voltage across the capacitor, one minute after disconnection of the ballast from a source of supply at rated voltage, does not exceed 50V.

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*Specification for accessibility test probes (*first revision*).

9.6 Voltage Across Capacitors — At rated frequency, the voltage across a capacitor incorporated in a ballast shall comply with the following requirements.

9.6.1 Under normal conditions, when the ballast is tested at the rated supply voltage, the voltage across the capacitor shall not exceed the rated voltage of the latter.

9.6.2 Under abnormal conditions (*see* **9.9.4**) when the ballast is tested at 110 percent of its rated supply voltage, the voltage across the capacitor shall not exceed its test voltage. If the test voltage is not marked, it is deemed to be equal to 1·3 times the rated voltage of the capacitor.

NOTE — These requirements do not apply to capacitors having a capacitance equal to or less than 0·1 μF.

9.7 Moisture Resistance and Insulation

9.7.1 *Insulation Resistance (Dry)* — This test may be carried out at the prevailing atmospheric temperature.

9.7.1.1 The insulation resistance shall be measured with a dc voltage of approximately 500V, 1 minute after application of the voltage. Ballasts having an insulating cover or envelope shall be rapped with tin foil.

9.7.1.2 The insulation resistance is then measured :

a) between live parts of different polarity which can be separated; and

b) between live parts and all external metal parts including the tin foil wrapping of external parts of insulating material.

9.7.1.3 The insulation resistance shall not be less than 5 M Ω in each case.

9.7.2 *Moisture Resistance* — The ballast shall be moisture resistance. It shall not show any appreciable damage after being subjected to insulation resistance (humid) test and high voltage test as described in **9.7.3** and **9.7.4** respectively.

9.7.3 *Insulation Resistance (Humid)* — The ballast is placed for 48 hours in a humidity chamber containing air with relative humidity maintained between 93 and 95 percent. The temperature of the air, at all places where ballasts can be located, is maintained at 40 ± 5°C.

9.7.3.1 Before being placed in the humidity chamber, the sample is brought to a temperature between t and $t + 4$°C. The ballast shall be mounted in accordance with the manufacturer's instructions (if any).

9.7.3.2 Cable entries (if any) shall be left open. If knockouts are provided, one of them shall be opened.

9.7.3.3 Before the insulation test, visible drops of water, if any, shall be removed by means of blotting paper.

9.7.3.4 Insulation resistance will be measured in accordance with **9.7.1.2** which shall not be less than 2 M Ω in each case.

9.7.4 *High Voltage Test* -- Immediately after the insulation resistance (humid) test, the ballast shall, in addition, withstand high voltage test. This test is made with appropriate ac voltage as mentioned in Table 3 at rated frequency for one minute between the parts as specified in **9.7.1.2**.

9.7.4.1 The full test voltage shall be applied gradually. The initial voltage shall not exceed 50 percent of the specified voltage and then the voltage shall be increased rapidly to the prescribed value.

TABLE 3 ONE MINUTE POWER FREQUENCY WITHSTAND VOLTAGE

(*Clauses* 9.7.4, 9.7.5.1 *and* 9.9.5)

WORKING VOLTAGE (U) V	TEST VOLTAGE V
Up to and including 42	500
Above 42 up to and including 1 000	$2U + 1000$

9.7.4.2 No flashover shall occur during the test.

9.7.5 *Inter-Turn Insulation* — Compliance is checked by submitting the windings to test as specified in **9.7.4**.

9.7.5.1 The test voltage shall be equal to five times the voltage occurring in normal use and steady state, at not less than five times the rated frequency, the test voltage shall not, however, exceed the values specified in Table 3.

9.7.5.2 During the test, there shall be no short circuit between winding.

9.8 Test for Thermal Endurance of Windings

9.8.0 Explanatory notes on ballast endurance testing are given in Appendix F.

9.8.1 Thermal endurance of the windings shall be checked in accordance with Appendix G.

NOTE — This test shall only be applied to ballasts which are marked with the maximum operating temperature, t_w.

9.8.2 Before the test, the following shall be checked and measured:

- a) The ballast shall start and operate a lamp normally, and
- b) The watt loss of the ballast shall be measured under normal operating conditions at rated supply voltage.

9.8.3 The thermal endurance test is intended to control the value of the rated maximum operating temperature. The thermal conditions shall be so adjusted that the objective duration of the test shall preferably be either 15 or 30 days although the manufacturers shall be free to adopt a longer test period at a lower temperature. If no indication is given, the duration of the test shall be 30 days.

9.8.4 After the test, when ballasts have returned to room temperature, they shall satisfy the following requirements:

- a) The ballast shall start and operate the lamp;
- b) The watt loss of the ballast, measured under normal operating conditions at rated supply voltage, shall not have changed by more than 10 percent from the value measured before the endurance test;
- c) The insulation resistance between the windings and the case, measured approximately at 500 V dc shall not be less than 1 M Ω; and
- d) The ballast shall withstand a test voltage as given in **9.7.4**. The test voltage, however, shall be twice the working voltage.

9.8.5 The result of the test shall be considered to be satisfactory if at least six of the seven ballasts satisfy these requirements.

The test shall be considered to be negative if more than two ballasts fail the test. In the case of two failures, the test shall be repeated with seven more ballasts and no failure of these ballasts shall be permitted.

9.9 Test for Limitations of Ballast Heating

9.9.1 Before the test, the following shall be checked and measured:

- a) The ballast shall start and operate the lamp normally,
- b) The resistance of the windings shall be measured at the ambient temperature, and
- c) The watt loss of the ballast shall be measured under normal conditions of operation at the rated supply voltage.

9.9.2 When the ballasts are tested in accordance with the requirements of Appendix H, the temperature-rise of those with marking of rated maximum operating temperature shall not exceed the appropriate values given in Table 4 for the tests under normal and abnormal conditions.

9.9.3 If materials or manufacturing methods other than those indicated in Table 4 are used, they shall not be exposed to temperatures higher than those which are proved to be permissible for these materials.

9.9.4 *Abnormal Conditions*

9.9.4.1 Abnormal conditions are working conditions in which one or the other of the following conditions apply:

a) The lamp or one of the lamps is not inserted;

b) One of the cathodes of a lamp is broken or de-activated;

c) A lamp does not start although the cathode circuits are intact (de-activated lamps); and

d) In switch start circuits, one starter is short-circuited.

9.9.4.2 For test purposes, the abnormal conditions shall be most severe of the conditions stated in (a) to (d) above.

9.9.4.3 In the case where a ballast is designed for more than one lamp, only the starter whose failure would cause the highest temperature-rise is short-circuited, with the unaffected lamp burning normally.

9.9.5 After these heating tests, ballast shall be allowed to attain the room temperature and shall comply with the following conditions:

a) The ballast markings shall be legible;

b) The ballast shall withstand, without damage, a voltage test as described in **9.7.4**, the voltage being reduced to 75 percent of the value given in Table 3, but not less than 500V;

c) The ballast losses under normal conditions, shall not vary by more than 10 percent from those measured before the heating test; and

d) During the test there shall be no seepage of compound or varnish. Minor seepage which shows no tendency to fall away shall be neglected.

9.10 Test for Mechanical Strength — The enclosures of independent ballasts shall have sufficient mechanical strength to allow them to withstand, without damage, the test specified in Appendix J.

9.11 Resistance to Heat

9.11.1 External parts of insulating material, providing protection against electric shock and parts of insulating material retaining live parts in position, shall be sufficiently resistant to heat when tested according to **9.11.1.1**, **9.11.1.2** and **9.11.1.3**.

TABLE 4 TEMPERATURE-RISE*

(*Clauses* 9.9.2 *and* 9.9.3)

PARTS	NOMINAL OPERATION AT 100 % OF RATED VOLTAGE °C	NOMINAL OPERATION AT 110 % OF RATED VOLTAGE °C	ABNORMAL OPERATION AT 110 % OF RATED VOLTAGE °C
a) Ballasts without temperature marking with windings of enamelled or varnished wire:			
With layers separated by paper or the like		70	130
With layers not separated by paper or the like		60	130
b) Ballasts with marking of rated maximum operating temperatures of the windings (t_w):			
Windings without t marking			
For t_w = 90°C	55‡		135§
95°C			142
100°C			150
105°C			158
110°C			165
115°C			173
120°C			181
125°C†			188
130°C†			195
Windings with t marking			
For t_w = 90°C	t‡		135§
95°C			142
100°C			150
105°C			158
110°C			165
115°C			173
120°C			181
125°C†			188
130°C†			195
c) For all ballasts:			
Capacitor enclosures:			
Without temperature making		15	25
With indication of rated maximum operating temperature (t_c)		$t_c - 35$	$1{\cdot}15\, t_c - 35$ or $t_c - 25$
Test hood (on the outside) (for built-in ballast)		60	100
Case of an independent ballast		60	100
Terminals for external wiring		40	—

(*Continued*)

TABLE 4 TEMPERATURE-RISE — *Contd*

PARTS	NOMINAL OPERATION AT 100 % OF RATED VOLTAGE °C	NOMINAL OPERATION AT 110 % OF RATED VOLTAGE °C	ABNORMAL OPERATION AT 110 % OF RATED VOLTAGE °C
Parts made of:			
Wood-filled phenolic mouldings		85	—
Mineral-filled phenolic mouldings		120	—
Urea mouldings		65	—
Melamine mouldings		75	—
Laminated, resin-bonded paper		85	—
Rubber		45	—
Thermoplastic materials		‖	—

*The values are based on an ambient temperature normally equal to 27 ± 2°C.

†If temperature-rise values under abnormal conditions for t_W values of 125°C and 130°C are required, provisionally, they can be calculated according to Appendix G taking 4 500 as the constant K used there. A change in this constant for t_W 120°C is under consideration.

‡The difference between the value of t_W and the measured temperature-rises gives an indication of the margin available for the thermal ambient in which the ballast might be placed, particularly when mounted in a luminaire.

§The temperature-rises of the windings, under abnormal conditions, correspond to a ballast life of at least 20 days at an ambient temperature of 35°C.

‖The temperature-rise of thermoplastic material, other than that used for the insulation of the wiring, which provides protection against contact with the live parts or supporting such parts, is also determined. The value so obtained will serve in order to establish the conditions of the test specified in **9.11**.

9.11.1.1 Enclosures and other external parts of insulating material are subjected to a ball-pressure test by means of the apparatus shown in Fig. 1.

9.11.1.2 The surface of the part under test is placed in the horizontal position and a steel ball of 5 mm diameter is pressed against this surface by a force of 20 N. The test is made in a heating cabinet at a temperature which is 50 ± 5°C in excess of the relevant part determined during the test as described in **9.9**, with a minimum of 125°C for parts retaining live parts in position. The test shall not be made on parts of ceramic material.

9.11.1.3 After 1 hour, the ball is removed and the diameter of the impression measured. This diameter shall not exceed 2 mm.

9.11.2 The test is not made on parts of ceramic material.

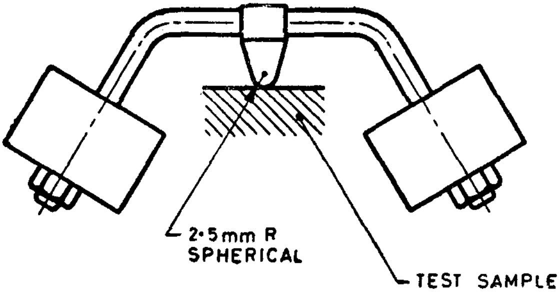

FIG. 1 BALL-PRESSURE APPARATUS

9.12 Test for Resistance to Corrosion

9.12.1 Ferrous parts, the rusting of which may endanger the safety of the ballast, shall be adequately rust-protected. This requirement applies to the outer surface of iron cores. Protection by varnish is deemed to be adequate for the outer surface of iron cores.

9.12.1.1 Compliance is checked by inspection.

9.12.2 Contacts and other parts made of rolled copper or copper alloy sheet, the failure of which might impair safety, shall be free from the possibility of stress corrosion cracking.

9.12.2.1 Compliance is checked by the following test:

The surface of the sample is carefully cleaned, varnish being removed by acetone, grease and fingerprints by petroleum, spirit or the like. The sample is kept for one hour in a saturated solution of mercuric chloride ($HgCl_2$) in water, at a temperature of 20 ± 5°C, then the samples are washed in running water. After a further 24 h, the sample shall show no cracks.

9.13 Performance

9.13.1 Ballasts which comply with this standard when associated with lamps complying with IS : 2418 (Part I)-1977 and IS : 2418 (Part II)-1977* and, where appropriate, operated with a starter complying with IS : 2215-1968† will provide satisfactory starting and operation of the lamps at temperatures down to 10°C or up to 50°C at 90 percent of the rated voltage. However, up to 50°C starting only and not immediate restarting may by secured.

9.13.2 Open circuit voltage at terminations of lamp or starters (if any).

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*Specification for tubular fluorescent lamps for general lighting service:
Part I Requirements and tests (*first revision*).
Part II Standard lamp data sheets (*first revision*).

†Specification for starters for fluorescent lamps (*second revision*)

9.13.2.1 For lamps operated with starters, ballast, when operated at any voltage between 90 percent and 110 percent of its rated voltage and at rated frequency shall provide the following open circuit voltages:

a) At terminations of the starter, a voltage of at least the values given in col 3 of Table 5.

b) At lamp terminations, a peak voltage (excluding the surge of the starter) not exceeding the values given in col 4 of Table 5.

When ballasts are designed to operate lamps in parallel circuits, the relevant requirements shall be met for each separate lamp, even under the most adverse load conditions.

TABLE 5 OPEN CIRCUIT VOLTAGE AT TERMINATION OF STARTER DIFFERENT LAMP WATTAGES

RATED LAMP WATTAGE	NOMINAL DIMENSIONS OF LAMP	MINIMUM OPEN-CIRCUIT VOLTAGE AT TERMINATIONS OF STARTER	MAXIMUM OPEN-CIRCUIT VOLTAGE AT LAMP TERMINATIONS
(1)	(2)	(3)	(4)
W	mm	V(rms)	V(peak)
20	500 × 38	95	400
40	1 200 × 38	180	400
65	1 500 × 38	180	400
80	1 500 × 38	180	400

9.13.3 *Pre-heating Conditions*

9.13.3.1 The ballast, when operated at any voltage between 90 percent and 110 percent of its rated voltage and at rated frequency, shall provide a pre-heating current whose ratio to the nominal running current is within the limits 0·9 and 2·1. For measurement of pre-heating current the lamp cathodes are each replaced by a resistance of the value given in Appendix H.

NOTE — The use of an uncompensated capacitative ballast resulting in the reduction in the pre-heating current has an unfavourable influence on the life of certain lamps.

9.13.4 *Power and Current Output*

9.13.4.1 The test shall be carried out as specified in Appendix K.

9.13.4.2 The ballast shall limit the power and current delivered to a reference lamp to be not less than 92·5 percent for the power and not more than 115 percent for the current of the corresponding values delivered to the same lamp when operated with a reference ballast. Both the reference ballast and the ballast under test shall have the same rated frequency and each shall be operated at its rated voltage.

Moreover, for any other supply voltage between 90 percent and 110 percent of its rated value, the power delivered by the ballast to the reference lamp shall lie between the limits of 85 percent of the power delivered to the same lamp by the reference ballast when supplied at 90 percent of its rated voltage and the limit of 115 percent of the power delivered to the lamp by the reference ballast when supplied at 110 percent of its rated voltage.

9.13.5 *Overall Power Factor* (λ) — The measured overall power factor shall not differ from the marked value by more than 0·05, when the ballast is operated with one or more reference lamps and the whole combination is supplied at the rated voltage and frequency. In cases where a minimum value of power factor is required for a ballast, it shall be 0·85 measured under the conditions stated above. For these high power factor ballasts, the measured value shall in no case be less than 0·85.

9.13.6 *Current Delivered to the Lamp* — At the rated voltage and frequency, the current delivered to the lamp shall not differ by more than ±10 percent from the value marked on the ballast when the latter is operated with a reference lamp.

9.13.7 *Current Waveform*

9.13.7.1 Mains current waveform applies independently of the starting system. The testing is carried out as described in Appendix M.

The waveform of the current passed in the steady state by a ballast associated with a reference lamp or lamps and supplied at rated voltage and rated frequency shall be such that the value of the *n*th harmonic shall not exceed the value specified in Table 6 expressed in percent of the fundamental component of the current.

TABLE 6 FUNDAMENTAL COMPONENT OF THE CURRENT

HARMONIC (1)	MAXIMUM VALUE EXPRESSED IN PERCENT OF FUNDAMENTAL COMPONENT OF THE CURRENT (2)
2	5
3	$25 \times \frac{\lambda^*}{0{\cdot}9}$
5	7
7	4
9	3
11	2
13 and above	1

* λ = Power factor of the lamp and ballast circuit.

9.13.7.2 *Lamp operating current waveform* — Test is carried out as described in Appendix M. The waveform of the current delivered in the steady state to a reference lamp associated with the ballast supplied at rated voltage and at rated frequency shall comply with the following conditions:

a) Successive half-cycles shall present similar forms on an oscilloscope and their peak values shall be equal to within 5 percent.

If measurement with the oscilloscope leave any doubt, the requirement shall be deemed as met if any even harmonic component does not exceed 5 percent of the fundamental current.

b) The maximum ratio of peak value to root-mean-square value shall not exceed 1·7 for all values of supply voltage between 90 percent and 100 percent of the nominal voltage and 1·8 for values above 100 percent and up to 110 percent.

NOTE — In border-line cases, it happens that the ballast may or may not comply with the requirements according to the specific reference lamp used for testing. Such a behaviour is linked with the slight permissible variations of current (±2·5 percent of nominal running current) drawn by the lamp when tested with a reference ballast.

It is necessary to repeat the test with different reference lamps whose current characteristics are located on both sides with respect to the ideal case and to plot the results in function of their current drawn when associated, under the prescribed conditions, with a reference ballast. The interpolated value (of crest factor or of harmonic content) corresponding to the nominal running current will then be the decisive one for assessing the compliance.

9.13.8 *Voltage Across Terminals of Voltage Operated Starter (if any)* — When a ballast is operating with a reference lamp and is connected to any voltage between 90 percent and 110 percent of the rated supply voltage at rated frequency, the voltage at the starter terminals shall not exceed the values given in Table 7.

TABLE 7 MAXIMUM VOLTAGE ACROSS STARTER TERMINALS

RATED LAMP WATTAGE (1)	MAXIMUM VOLTAGE ACROSS STARTER TERMINALS (2)
W	V(rms)
20	68
40	128
65	132
80	128

9.13.8.1 The limits specified in Table 7 shall apply both when the lamp is first ignited and after it has warmed up.

9.13.8.2 When ballasts are designed to operate lamps in parallel circuits, the relevant requirements shall be met for each separate lamp, even under the most adverse load conditions.

9.13.9 *Protection Against Magnetic Influence* — The ballast shall be suitably protected against magnetic influence. This test is made on the ballast in normal operation with a lamp. A steel plate 1 mm thick and of length and breadth greater than those of the ballast under the test, is successively moved into proximity with each face of the latter. This plate is brought into contact with the face of the ballast used for fixing but is held at a distance of 1 mm from other faces. During this operation, the current by the ballast at the rated voltage is measured. The variation of this current caused by the proximity of the steel plate shall not exceed by 2 percent of its value.

APPENDIX A

(*Clauses* 2.2 *and* 2.3)

REFERENCE BALLASTS

A-1. MARKING

A-1.1 The reference ballast shall be provided with durable and legible marking as follows:

- a) The words ‘ Reference Ballast ’ in full,
- b) Identification of the responsible vendor,
- c) Serial number,
- d) Rated lamp wattage and calibration current, and
- e) Rated supply voltage and frequency.

A-2. DESIGN CHARACTERISTICS

A-2.1 General Design — A reference ballast is a self-inductive coil, with or without an additional resistor, designed to give the operating characteristics as mentioned in **A-3**. It is always operated with a starter, without respect to the type or lamp with which it is used.

A-2.2 Protection — The reference ballast shall be protected (for example, by means of a suitable steel case) against magnetic influence, in such a way that its ratio of voltage to current for the calibration current shall not be changed more than 0·2 percent when a 12·5 mm thick plate of ordinary mild steel is placed at 25 mm from any face of the ballast enclosure. Moreover, it shall be protected against mechanical damage.

A-3. OPERATING CHARACTERISTICS

A-3.1 Rated Supply Voltage and Frequency — The rated supply voltage and frequency of a reference ballast shall be in accordance with the values given in Table 8.

A-3.2 Ratio of Voltage to Current — The ratio of voltage to current of a reference ballast shall have the values given in Table 8 subject to the following tolerances:

a) ±0·5 percent at the calibration current values; and

b) ±3 percent at any other value of current from 50 to 115 percent of the calibration current.

A-3.3 Power Factor — The power factor of a reference ballast determined at the calibration current shall be as shown in Table 8 subject to a tolerance of ±0·005.

A-3.4 Temperature-Rise — When the reference ballast is operated in an ambient air temperature between 25°C and 29°C at calibration current and rated frequency, the steady state temperature-rise of the ballast winding shall not exceed 25°C when measured by the resistance method.

TABLE 8 LAMP TYPES AND CHARACTERISTICS OF REFERENCE BALLASTS AT 50 Hz

(*Clauses* A-3.1, A-3.2 *and* A-3.3)

RATED LAMP WATTAGE	RATED VOLTAGE	CHARACTERISTICS OF REFERENCE BALLASTS		
		Calibration Current	Ratio Voltage/Current	Power Factor
(1)	(2)	(3)	(4)	(5)
W	V	A		
20	127	0·37	270	0·12
40	220	0·43	390	0·10
65	220	0·67	240	0·10
80	240	0·865	223	0·06

APPENDIX B

(*Clauses* 2.3 *and* E-5.6)

REFERENCE LAMPS

B-1. A lamp which has been aged for at least 100 hours is considered to be a reference lamp if, when associated with a reference ballast under normal testing conditions as defined in Appendix E and operating in an ambient temperature of 27°C, neither the lamp wattage, lamp voltage nor lamp current deviate by more than 2·5 percent from the corresponding values given in IS : 2418 (Part I)-1977 and IS : 2418 (Part II)-1977*.

B-2. The waveform of the current supplied in the steady state to a reference lamp associated with a reference ballast shall show substantially the same wave-shape in successive half-cycles.

NOTE 1 — This limits the possible generation of even harmonics by any rectifying effect.

NOTE 2 — Although the reference lamp must always belong to a type appropriate to the ballast to be tested, its selection is always made using a reference ballast. Such a procedure allows in particular a simple measurement of its power.

APPENDIX C

(*Clauses* 2.12 *and* 5.1.2)

TEST FOR SCREWS TRANSMITTING CONTACT PRESSURE

C-1. The screws or nuts are tightened and loosened:

a) 10 times for screws in engagements with a thread of insulating material, and

b) 5 times for nuts and other screws.

C-1.1 Screws in engagement with a thread of insulating material are completely removed and reinserted each time.

C-2. When testing terminal screws and nuts, a solid conductor of the largest cross section as described in **4.1.1** of this standard is placed in the terminal. The test is made by means of a suitable test screw driver or spanner applying a torque as shown in Table 9. Column 1 applies to screws without heads if the screws when tightened do not protrude from the hole. Column 2 applies to other screws and to nuts.

C-2.1 The conductor is moved each time the screw or nut is loosened. During the test, no damage impairing the future use of the screwed connections shall occur.

C-2.2 Screws which may be operated when connections are made to the auxiliaries include, for example, terminal screws, screws for fixing covers when they have to be loosened to open the auxiliary, etc. Conduit thread connections and screws to fasten the auxiliaries to their supports are excluded.

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*Specification for tubular fluorescent lamps for general lighting service:
Part I Requirements and tests (*first revision*).
Part II Standard lamp data sheets (*first revision*).

TABLE 9 TORQUE

(*Clause* C-2)

Nominal Diameter of Screw	Torque	
(1)	(2)	(3)
mm	Nm	Nm
Up to and including 2·8	0·2	0·4
Over 2·8 up to and including 3·0	0·25	0·5
Over 3·0 up to and including 3·2	0·3	0·6
Over 3·2 up to and including 3·6	0·4	0·8
Over 3·6 up to and including 4·1	0·7	1·2
Over 4·1 up to and including 4·7	0·8	1·8
Over 4·7 up to and including 5·3	0·8	2·0
Over 5·3 up to and including 6·0	—	2·5

C-2.3 The shape of the blade of the test screw driver shall suit the slot of the screw to be tested. The screw shall not be tightened in jerks. Nuts are tested in a similar manner. Damage to covers is neglected.

APPENDIX D

(*Clause* 9.0)

GENERAL REQUIREMENTS FOR TYPE TESTS

D-1. AMBIENT TEMPERATURE

D-1.1 The control of temperature within the test room or the test enclosure shall be such that:

a) the temperature at any point in the test room or enclosure shall remain within 27 + 2°C throughout the period of control; and

b) the variation of temperature with time, in the region where a series of tests is being run in the test room or the enclosure, shall be within ±1°C of the mean temperature of that region during the series of tests.

D-2. SUPPLY VOLTAGE AND FREQUENCY

D-2.1 The supply voltage and frequency shall be as follows:

a) *Test Voltage and Frequency* — Unless otherwise specified, each ballast to be tested, and also the reference ballast, shall be operated at its own rated supply voltage and at its rated frequency. The reference ballast shall be of the same frequency rating as ballast under test.

When the ballast is marked for use on a range of supply voltages or has different rated supply voltage, any voltage for which it is intended may be chosen as the rated nominal voltage.

b) *Stability of Supply Voltage and Frequency* — For the majority of the tests, the supply voltage and frequency shall be maintained constant within ±0·5 percent. However, during the actual measurements, the voltage shall be adjusted to within ±0·2 percent of the specified test value. For tests of long duration (for example, endurance test), the variation of voltage may be ±2 percent and frequency ±1 percent of the specified value.

c) *Supply Voltage Waveform* — The total harmonic content of the supply voltage shall not exceed 3 percent, harmonic content being defined as the root-mean-square (rms) summation of the individual harmonic components, using the fundamental as 100 percent.

NOTE — The internal impedance of the power source shall be low relative to the impedance of the ballast. Care shall be taken to see that this requirement is met under all conditions that occur during the measurement.

D-3. INSTRUMENT CHARACTERISTIC

D-3.1 The instrument characteristic shall be as follows:

a) *Potential Circuits* — Instruments connected across the lamp shall have sufficiently high impedance such that they do not draw more than 3 percent of the nominal running current.

b) *Current Circuits* — Instruments connected in series with the lamp shall have sufficiently low impedance such that the voltage drop across the instrument shall not exceed 2 percent of the objective lamp voltage. Where measuring instruments are inserted in parallel with the heating circuits, the total impedance of the instrument shall not exceed 0·5 ohm.

c) *RMS Measurement* — Instrument shall be essentially free from errors due to waveform distortion.

D-4. MAGNETIC EFFECTS

D-4.1 Unless otherwise specified, no magnetic object shall be allowed within 25 mm of the face of the reference ballast or ballast under test.

D-5. ADDITIONAL TESTING REQUIREMENTS FOR REFERENCE BALLAST AND SELECTING REFERENCE LAMPS

D-5.1 Mounting and Connections of Reference Lamps

a) *Mounting* — In order to make the reference lamps repeat their electrical values with the greatest consistency, it is recommended that the lamps be mounted horizontally and allowed to remain permanently in their test lampholders.

b) *Reference Lamps Operated with Starter* — The lamp shall be aged with one disposition of contact connections only and shall be used in the same disposition.

c) *Reference Lamps Operated Without Starter* — The above conditions shall be complied with so far as the identification of the ballast terminations corresponding to the main circuit will permit.

D-5.2 Reference Lamp Stability

D-5.2.1 The details of reference lamp stability shall be as follows:

a) A lamp shall be brought to a condition of stable operation before carrying out measurements. No swirling shall be present.

b) The characteristics of a lamp shall be checked immediately before and immediately after each series of tests.

D-5.3 Measurement of Ratio of Voltage to Current — Figure 2 gives a typical testing circuit. If this circuit is used, no correction need be made for the current drawn by the voltmeter, provided that the resistance of the voltmeter complies with the requirements of **D-3**.

If the frequency is not exactly f_n, a correction to be made shall be applied in accordance with the following formula:

$$\text{Voltage at } f_n = (\text{ voltage at frequency } f) \times \frac{f_n}{f}$$

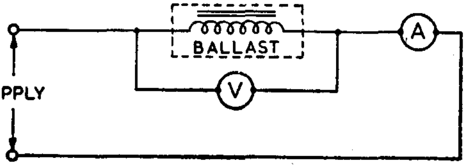


FIG. 2 RECOMMENDED CIRCUIT FOR MEASUREMENT OF VOLTAGE/CURRENT RATIO

D-5.4 Measurement of Power Factor — Figure 3 gives a typical circuit for the determination of the power factor. A suitable correction shall be made for instrument losses.

D-5.5 Checking Protection Against Magnetic Influence — The steel plate, referred to in **A-2** of Appendix A shall have dimensions at least 25 mm greater than the corresponding projection of the enclosure and shall be placed in geometric symmetry to each surface as tested.

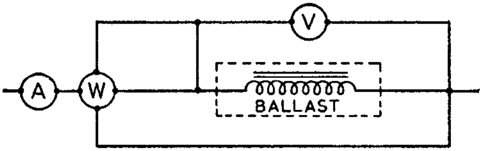


FIG. 3 RECOMMENDED CIRCUIT FOR DETERMINATION OF POWER FACTOR

D-5.6 Selection of Reference Lamps — Figure 4 gives a recommended circuit for selecting reference lamps. After the lamp has struck, the starting device shall be taken out of the circuit.

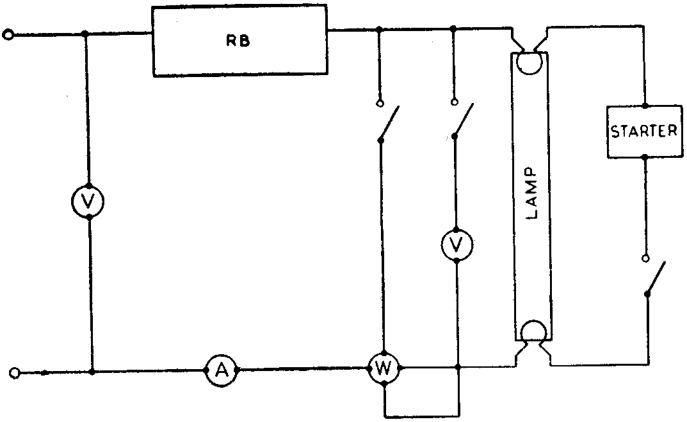


FIG. 4 RECOMMENDED CIRCUIT FOR SELECTION OF REFERENCE LAMPS

D-5.6.1 When stable burning conditions are reached, the current, voltage and power of the lamp shall be measured for compliance with Appendix B.

D-5.6.2 When measuring the voltage or power of the lamp, the potential circuit of the instrument, not in use, shall be open.

D.5.6.3 When measuring lamp watts, no corrections shall be made for the wattmeter consumption (the common connection being made on the lamp side of the current coil).

NOTE — The reference to the absence of a correction for the consumption of the voltage circuit of the wattmeter arises from the fact that, in most cases, at the same supply voltage, the said load compensates approximately for the reduction of the power consumption of the lamp caused by the parallel connection of the voltage circuit of the wattmeter. If any doubts are felt on this point, it will always be possible to evaluate the compensation error by repeating the measurements with other values of the load in parallel with the lamp. This is done by adding resistances in parallel and by reading each time the power measured by the wattmeter. It is then possible to extrapolate the results obtained in order to determine the true wattage in the absence of any parallel load.

APPENDIX E

(*Clauses* 9.2.1 *and* B-1)

SAMPLING PROCEDURE FOR ACCEPTANCE PURPOSE

E-1. LOT

E-1.1 In any consignment, all the ballasts of the same make, model and type and manufactured under similar condition of production shall be grouped together to constitute a lot.

E-2. SELECTION OF SAMPLES

E-2.1 The number of ballasts to be selected at random from a lot shall depend on the size of the lot and shall correspond to the value specified in col 2 of Table 10 for the various sizes referred to in col 1. All the ballasts shall be subjected to the acceptance tests specified in **9.2**.

E-2.1.1 If required for repeat tests (*see* **F-3.2**) additional number of samples of ballasts shall also be selected at random as given in col 3 of Table 10.

TABLE 10 SAMPLING PLAN

(*Clauses* E-2.1, E-2.1.1 *and* E-3.1)

BATCH SIZE (1)	N_1 (2)	N_2 (3)	($N_1 + N_2$) (4)	C_1 (5)	C_2 (6)
51 to 100	10	20	30	0	3
101 ,, 200	13	26	39	0	5
201 ,, 300	20	40	60	1	5
301 ,, 500	25	50	75	1	6
501 ,, 800	35	70	105	2	7
801 ,, 1 300	50	100	150	3	10
1 301 and above	75	150	225	5	12

NOTE — The plan recommended in this table assures that lots with defectives 4 percent or less would be accepted most of the time, and lots with defectives 25 percent and above would be rejected most of the time. The exact consumer's risk depends on the lot size and it would be minimum when the lot size is maximum.

E-3. CRITERION FOR CONFORMITY

E-3.1 The lot shall be considered as conforming to the requirements of acceptance tests if the number of failures in the first sample is less than or equal to acceptance number C_1 given in col 5 of Table 10. If the number of failures is greater than or equal to the rejection number C_2 as given in col 6 of Table 10, the lot shall be considered as not conforming to the requirements of the acceptance tests.

E-3.2 If the number of failures is between C_1 and C_2 a further sample of N_2 lampholders shall be selected and subjected to the acceptance tests. If the number of failures in the two samples combined is less than C_2 the lot shall be considered as conforming to the requirements of acceptance tests or otherwise not.

APPENDIX F

(*Clause* 9.8.0)

EXPLANATORY NOTES ON BALLAST ENDURANCE TESTING

F-1. INTRODUCTION

F-1.1 The intention of this appendix is to investigate ballast endurance testing, based on the t_w concept and, in particular, to determine the constant(s) required in the formula relating to test life and actual ballast life for t_w values greater than 120°C.

F-2. THEORETICAL BASIS

F-2.1 The present life versus temperature relationship for insulation systems of ballasts is based on the following equation:

$$L = Ke^{D/T}$$

where

L = life of the insulation system in days,
T = absolute temperature of the insulation in K,
D = constant which is related to the insulation material,
e = base of napierian logs = 2·718, and
K = equation constant which depends upon the units chosen.

F-2.2 If an insulation system is tested at two different temperatures, it will give two different lives and then two equations can be written thus:

$$L = Ke^{D/T} \qquad L_o = Ke^{D/T_w}$$

where

L = objective test life in days at temperature T,
L_o = 3 652 days (10 years),
T = objective test temperature (absolute) in K, and
T_w = rated maximum operating temperature (absolute) in K.

Then:

$$\frac{L}{L_o} = \frac{Ke^{D/T}}{Ke^{D/T_w}}$$

and taking $\log_{10}$ of both sides:

$$\log L - \log L_o = \frac{D}{T}\log_e - \frac{D}{T_w}\log_e$$

Since log e is also a constant it can be included with D the material constant to give a new constant P = D log e; and therefore:

$$\log L - \log L_o = P\left(\frac{1}{T} - \frac{1}{T_w}\right)$$

and therefore,

$$\log L = \log L_o + P\left(\frac{1}{T} - \frac{1}{T_w}\right)$$

The value of the constant P, which has been adopted empirically is 4 500 for values of t_w up to and including 120°C.

F-3. BASIC MATERIAL TESTS

F-3.1 The temperature classification of enamelled winding wires is frequently based on IS : 5825-1970*. Test procedure for the evaluation of the thermal endurance of enamelled wire by the lowering of the electric strength between twisted wires on twisted wire tests; twisted pair tests and curves are published by wire manufacturers. The standard wire diameter for this test is 0·8 mm. Samples prepared in a specified manner are tested in an oven at various temperatures for the time taken for breakdown between wires. The test voltage is 1 000 V. The inverse absolute temperature is plotted against time on a logarithmic scale and the curve is extrapolated to 20 000 hours. The corresponding temperature is taken as the thermal classification of the enamelled wire.

F-3.2 The data produced by various wire manufacturers does not agree very closely but the slopes (constant P) of the curves for insulation materials classified in IS : 1271-1958†. However, the classification according to twisted pair tests is based upon a 20 000 hours life (2·4 years) and if, for example, the line for a typical Class E (120°C) insulation is extrapolated from 20 000 to 87 000 hours (10 years), the temperature is 98°C, which is lower than Class A.

F-3.3 Moreover, in an endurance test on twisted pairs, the wire is at a uniform temperature, whereas where a wound component is tested there is a hot spot in the winding which may have a temperature of 10°C higher than the average temperature upon which the test is based.

---

*Guide for evaluation of thermal endurance of enamelled wires.

†Classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability in service.

F-4. MATERIALS IN BALLASTS

F-4.1 The basic material tests show that different constants are required for different insulating classes. When using these same materials in ballasts, it is to be expected that other constants will apply. The ballast constants will take into account not only the winding wire characteristics but also the characteristics of other materials included construction and the different testing methods.

F-4.2 From the previous considerations and the results of the limited number of tests which have been carried out, it would appear that to pass a $t_w = 120°C$ test, a ballast must be mound with a wire rated 155°C, that is, a polyester enamelled wire. Similarly, a $t_w = 155°C$ ballast would need a 180°C wire (polyester-imide).

F-4.3 Accordingly, the curves have slopes (constant P) corresponding to those of insulating enamels two classes higher, by the twisted pair test, then the t_w marked temperatures of 130°C and 155°C.

F-4.4 It is believed that the t_w test temperatures, derived from these curves, are sufficiently conservative to allow for differences in materials and construction of ballasts.

F-4.5 These t_w values are submitted for trial. Much more testing is necessary and when more results are available the curves may need to be adjusted.

F-5. ENDURANCE TESTING PERIOD

F-5.1 At the present time, the testing normally lasts 30 days, unless the manufacturer indicates otherwise, and is related to the constant of 4 500. When this constant changes to a higher value, the testing sensitivity and accuracy are reduced and a longer testing time is necessary.

APPENDIX G

(*Clause* 9.8.1)

THERMAL ENDURANCE TEST FOR WINDINGS

G-1. The test is carried out in an appropriate oven.

NOTE — Figure 5 shows a suggested design of oven.

G-1.1 According to practical experience, uniform and stable temperature can be achieved:

a) either by an oven without very good thermal insulation, or

b) by very good insulation of the ballast so that heat generated inside the ballast itself provides (most of) the heat needed for the test.

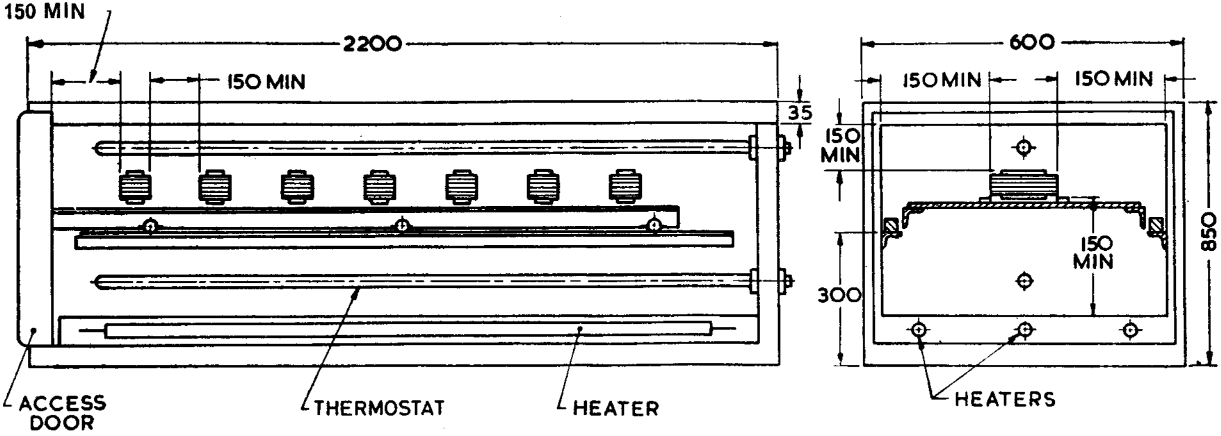


FIG. 5 DIMENSIONS AND LAYOUT OF A TYPICAL HEATING CABINET

The description below refers to the 'oven method' using thermostats. When 'self-heating' is used, the current through the ballast should be kept constant using other means.

G-2. The ballast shall function electrically in a manner similar to that in normal use. In case of capacitors or other auxiliaries which should not be subjected to the test, these shall be disconnected and reconnected again in a circuit but outside the oven. Other components which do not influence the operating conditions of the winding may be removed. The ballast shall be earthed.

NOTE — In case where it is necessary to disconnect capacitors or other auxiliaries which should not be subjected to the test, it is recommended that the manufacturer supplies special ballasts with these parts removed and any necessary additional connections brought out from the ballast.

G-3. The batch of seven ballasts is placed in the oven, observing the minimum space limits prescribed in Fig. 5 and the rated voltage is applied to the circuits.

G-3.1 The oven thermostats are then varied in such a way that the internal temperature of the oven attains a value such that the temperature of the hottest winding in the ballast is approximately equal to the objective value given in Table 11.

TABLE 11 OBJECTIVE TEST TEMPERATURE

RATED MAXIMUM OPERATING TEMPERATURE (t_w)	OBJECTIVE TEST TEMPERATURE FOR LIFE TEST PERIOD OF	
	15 Days	30 Days
(1)	(2)	(3)
°C	°C	°C
90	176	163
95	183	170
100	191	177
105	199	185
110	207	192
115	215	199
120	223	207
125	231*	214*
130	239*	221

*These values are under consideration.

G-4. After 4 hours, the actual temperature of the winding is determined by the increase-in-resistance method and, if necessary, the oven thermostats are re-adjusted to approximate as closely as possible the objective test temperature. Thereafter, a daily reading of the air temperature in the oven shall be taken to ensure that the thermostats are maintaining the correct value to within ± 2°C.

G-4.1 The winding temperatures are measured against after 24 hours and the final test period for any ballast shall be determined from the curve given in Fig. 6. The permissible difference between the actual temperature of the hottest winding of any of the ballasts under test and the objective value shall be such that the final test period is not less than 10 days for an objective life of 15 days, nor more than 60 days for an objective life of 30 days.

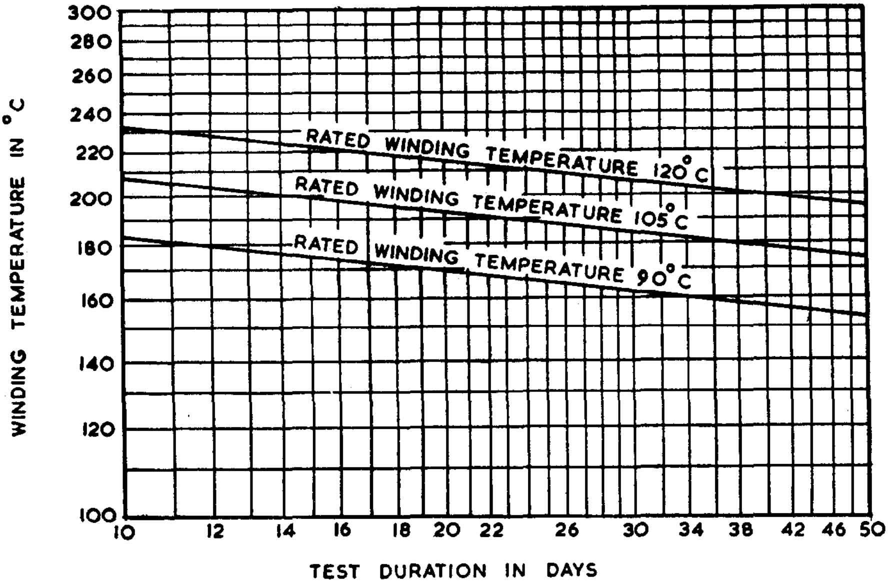


FIG. 6 RELATION BETWEEN WINDING TEMPERATURE AND TEST DURATION

G-4.2 No attempt shall be made to hold constant the winding temperature after the measurement at 24 hours. Only the ambient air temperature should be stabilized by the thermostatic control.

G-4.3 The test period, for each ballast commences from the time the ballast is connected to the supply. At the end of its test, the relevant ballast is disconnected from the supply, but is not removed from the oven until the tests on the other ballasts have been completed.

G-5. The objective test temperature given in Table 9 should correspond to a working life of 10 years continuous operation at the rated maximum operating temperature.

G-5.1 They are calculated on the basis of the following formula:

$$\text{Log } L = \log L_o + 4\,500\left(\frac{1}{T} - \frac{1}{t_w}\right)$$

where

L = objective test life in days,
L_o = 3 652 days (10 years),
T = theoretical test temperature in °K, and
t_w = rated maximum operating temperature in °K.

The constant 4 500 has been established empirically.

APPENDIX H

(*Clauses* 9.9.2 *and* 9.13.3.1)

LIMITATION OF BALLAST HEATING

H-1. BALLASTS WITHOUT TEMPERATURE MARKING

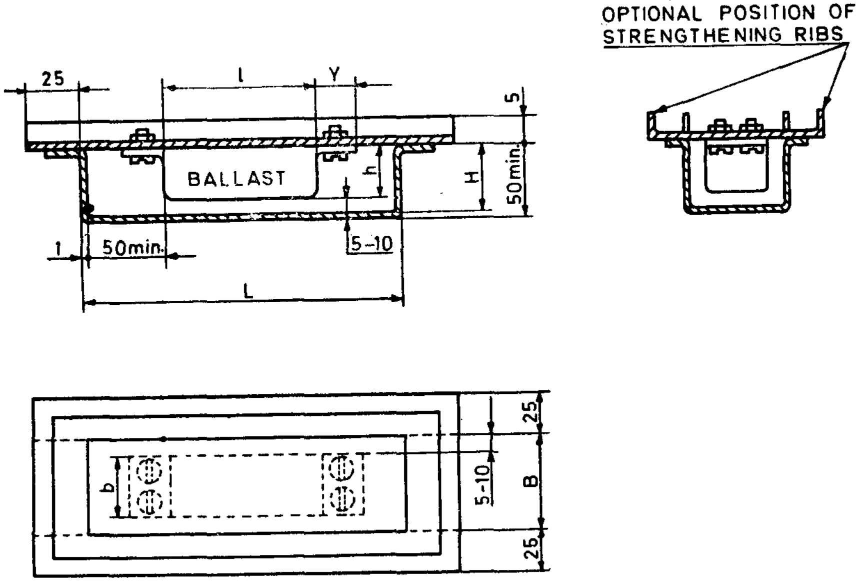
H-1.1 Built-in ballasts shall be tested under normal and abnormal conditions in accordance with the following details at 1·1 times rated supply voltage and at rated frequency with appropriate lamps until steady temperature-rises are attained.

Note — Lamps shall be deemed to be appropriate if they take, under prescribed test conditions, a current not deviating more than 2·5 percent from the current a reference lamp would take.

H-1.2 The ballast shall be placed centrally in a hood of sheet metal 1 mm thick and painted white inside and outside and mounted on a metal support. The ballast shall be mounted in accordance with the manufacturer's instructions (if any).

H-1.2.1 In the absence of such instructions, it is fixed centrally and directly against the supporting surface of the hood, using all fixing holes up to a maximum of four. Details of the hood and support are shown in Fig. 7.

H-1.2.2 In the case of ballasts having cross-sectional dimensions less than 60 × 40 × 50 mm, test hood as shown in Fig. 7 shall be used, regardless of the value of the clearances between the ballast and the test hood.



All dimensions in millimetres.

V — length of mounting lug

L — *l* + 100 mm but at least 500 mm

H — *h* + 5 mm to 20 mm, but at least 50 mm

B — *b* + 10 mm to 20 mm, but at least 80 mm

NOTE — The hood consists of 1 mm thick steel sheet, painted white inside and outside.

FIG. 7 HOOD FOR HEATING TEST

H-1.2.3 During the test, the testing device is freely supported, the ballast being pendant.

H-1.3 Temperatures are measured on windings, if possible by the resistance method, and in all other cases by means of a thermocouple. Measurement of watts loss of the ballast at normal operating conditions at rated supply voltage and rated frequency is made before and after the test to check for any occurrence of short-circuited turns during the test.

H-1.4 For the test under normal conditions, ballasts are operated with lamps burning normally. The lamps shall be placed in such a way that the heat generated does not contribute to the temperature rise of the ballast.

NOTE — If the ballast is a simple impedance in series with the lamp, the test and measurement may be made without lamp provided that the current is adjusted to the value corresponding, in normal operation, to a supply voltage of 1·1 times its rated value.

H-1.5 For test under abnormal conditions, the two cathodes of the lamp shall be replaced by equivalent resistances as specified in Table 12.

TABLE 12 EQUIVALENT RESISTANCE OF CATHODES FOR LAMPS OPERATED WITH STARTERS

RATED LAMP WATTAGE	EQUIVALENT RESISTANCE OF BOTH LAMP CATHODES
(1)	(2)
W	ohms
20	50
40	40
65	25
65/80	25

H-1.6 Independent Ballasts — The ballasts shall be tested without additional hood in a test corner consisting of three dull black painted boards at least 15 mm thick and arranged so as to imitate two walls and the ceiling of a room. The ballast is secured to the ceiling of the test corner as close as possible to the walls, the ceiling extending at least 250 mm beyond the other sides of the ballast.

H-1.6.1 Other test conditions and procedure shall remain the same as described in **H-1.1** to **H-1.5**.

H-2. BALLASTS WITH TEMPERATURE MARKING

H-2.1 The ballasts shall be tested under the same conditions as those without temperature marking, except for the following conditions.

H-2.2 Ballasts with t_w Marking — The test is first made at the rated supply voltage until stable conditions are reached, then the temperature rises of the windings are measured. After this, the supply voltage is adjusted to 1·1 times the rated value in order to check the temperature rises of every component. The test under abnormal conditions is only made under 1·1 times the rated supply voltage.

H-2.3 Built-in Ballasts with Both t_w and $\triangle t$ Marking — In addition to the conditions specified in **H-2.2** ballasts with both t_w and $\triangle t$ marking shall be tested for normal conditions (with a reference lamp or a similar lamp) under conditions of normal supply and frequency in the following arrangement of mounting in the test hood.

H-2.3.1 When the supporting surface is a continuous metal plate, the ballast is mounted in the test hood spaced at the two ends by steel spacers, 2 mm in thickness, of a width equal to that of the ballast and of a length equal to $m + 10$ mm, m being the length of the mounting lug which extends beyond the body of the ballast (*see* Fig. 7).

H-2.3.2 These conditions of mounting should permit each spacer to extend 10 mm under the body of the ballast. All the fixing holes provided for the ballast shall be used. Otherwise, the test hood is the same as that shown in Fig. 7.

NOTE — The above method of mounting need not be adopted when the ballast is of a type incorporating mounting pads which will ensure that the specified spacing is provided between the body of the ballast and the mounting surface.

APPENDIX J

(*Clause* 9.10)

TESTING OF MECHANICAL STRENGTH OF INDEPENDENT BALLASTS

J-1. Mechanical strength of the ballasts is tested by applying blows to the sample by means of the spring operated test apparatus shown in Fig. 8.

NOTE — As an alternate to Spring Hammer Test, Pendulum Hammer Test shall also be applicable for testing mechanical strength of independent ballasts. Details of the impact test apparatus for pendulum hammer test can be had from Appendix E of IS : 302-1973*.

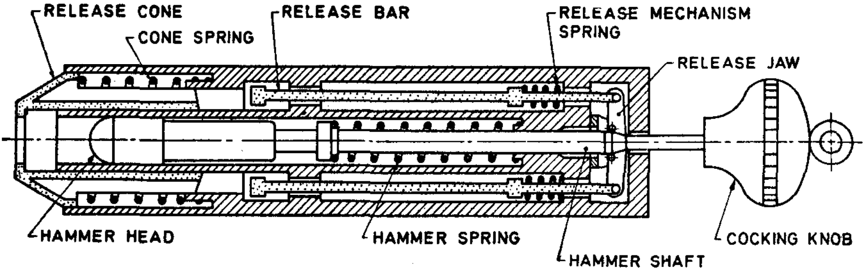


FIG. 8 IMPACT-TEST APPARATUS

J-2. The apparatus consists of three main parts: the body, the striking element and the spring-loaded release cone. The body comprises the housing, the striking element guide, the release mechanism and all parts rigidly fixed thereto. The mass of this assembly is 1 250 g.

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*General and safety requirements for household and similar electrical appliances.

J-2.1 The striking element comprises the hammer head, the hammer shaft and the cocking knob. The mass of this assembly is 250 g.

J-2.2 The hammer head has a hemispherical base of polyamide, having a rockwell hardness of R 100, with a radius of 10 mm; it is fixed to the hammer shaft in such a way that the distance from its tip to the plane of the front of the cone, when the striking element is on the point of release, is equal to the value shown for the compression in Table 13.

TABLE 13 IMPACT ENERGY

BALLAST (1)	IMPACT ENERGY (2) Nm	COMPRESSION (3) mm
Ballast cased in insulating material	0·22	14
Ballast cased in metal	0·35	17

J-2.2.1 The cone has a mass of 60 g and the cone spring is such that it exerts a force of 20 N when the release jaws are on the point of releasing the striking element.

J-2.2.2 The hammer spring is such that the product of the compression in millimetres, and the force exerted, in newtons, equals 1 000, the compression being approximately 20 mm. The spring is adjusted so as to cause the hammer to strike with an impact energy as shown in Table 13.

J-3. The release mechanism springs are adjusted so that they can exert just sufficient pressure to keep the release jaws in the engaged position.

J-3.1 The apparatus is cocked by pulling the cocking knob until the release jaws engage with the groove in the hammer shaft.

J-3.2 The blows are applied by putting the release cone against the sample in a direction perpendicular to the surface at the point to be tested.

J-3.3 The pressure is slowly increased so that the cone moves back until it is in contact with the release bars, which then move to operate the release mechanism and allow the hammer to strike.

J-3.4 The sample is rigidly supported, cable entries being left open, knock-outs opened and cover fixing and similar screws tightened with a torque equal to two-thirds of that specified in Table 9.

J-3.5 Three blows are applied to every point that is likely to be weak, paying special regard to insulating material enclosing live parts and to bushing of insulating material, if any.

J-4. After the test, the sample shall show no damage within the meaning of this recommendation.

J-4.1 Damage to paint and small dents which do not influence creepage distances or clearances are neglected. After the test, the resistance to moisture shall not be decreased.

J-4.2 Ballasts with metal enclosures, after being subjected to test as described in **J-1** to **J-3** are further subjected to the following tests:

a) A test finger, similar to that shown in Fig. 9 but not flexible, is pressed perpendicular with a force of 50 N on different points of the enclosure.

b) After this test, the sample shall show no damage.

NOTE — Damage to paint and small dents which do not influence creepage distances or clearances are neglected.

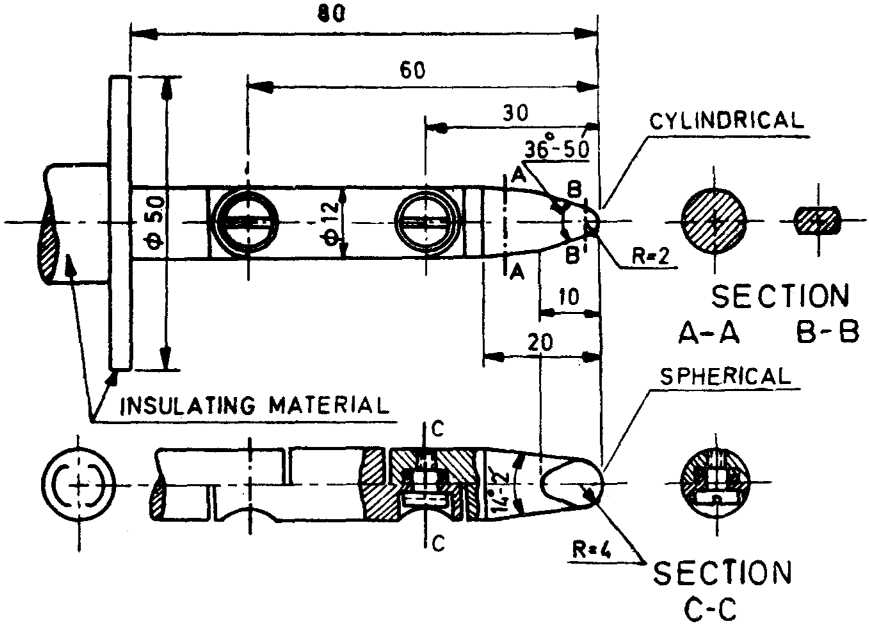

FIG. 9 STANDARD TEST FINGER

APPENDIX K

(*Clause* 9.13.4.1)

MEASUREMENT OF POWER AND CURRENT OUTPUT

K-1. A suitable testing circuit is shown in Fig. 10.

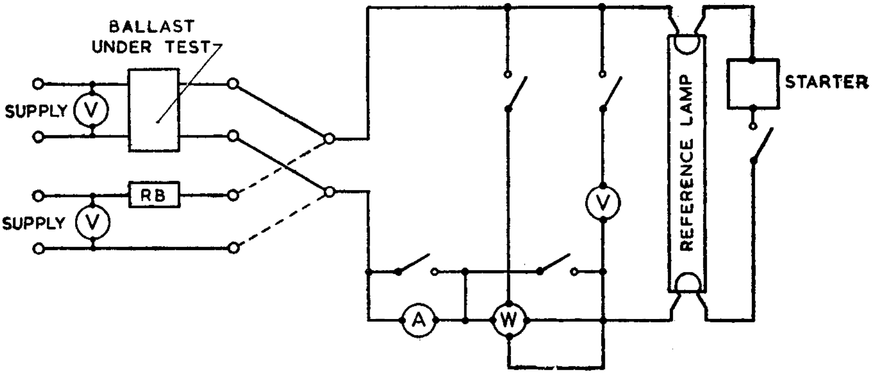

FIG. 10 MEASUREMENT OF POWER AND CURRENT OUTPUT

K-1.1 Measurements shall be made with the starting device taken out of the circuit. In the lamp circuit, potential circuits shall not be used across the contacts used for starter.

K-1.2 When measuring the voltage or power of the lamp, any potential circuit of the instruments not in use shall be open.

K-1.3 When measuring lamp watts, no correction shall be made for the watt meter consumption (the common connection being made on the lamp side of the current coil).

NOTE — The reference to the absence of a correction for the consumption of the voltage circuit of the watt meter arises from the fact that, in most cases, at the same supply voltage, the said load compensates approximately for the reduction of the power consumption of the lamp caused by the parallel connection of the voltage circuit of the watt meter.

If any doubts are felt on this point, it will always be possible to evaluate the compensation error by repeating the measurements with other values of the load in parallel with the lamp. This is done by adding resistances in parallel and by reading each time the power measured by the wattmeter. It is then possible to extrapolate the result obtained in order to determine the true wattage in the absence of any parallel load.

APPENDIX M

(*Clauses* 9.13.7.1 *and* 9.13.7.2)

MEASUREMENT OF CURRENT WAVEFORM

M-1. Figure 11 shows the diagram of the circuit to be used.

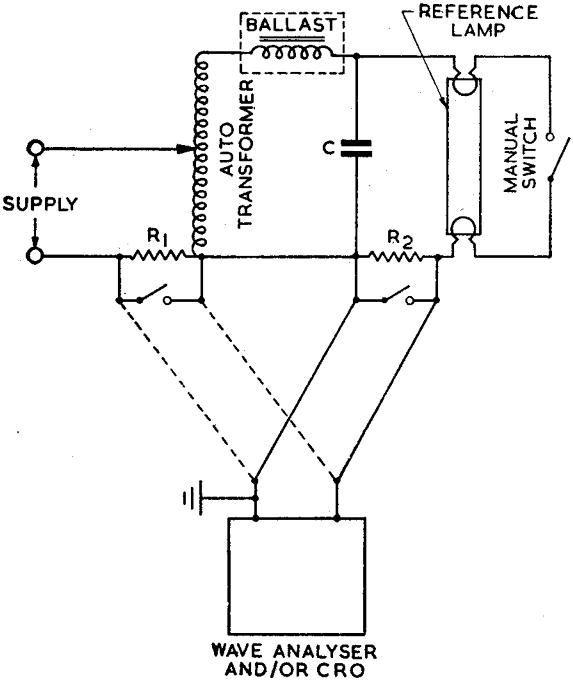

FIG. 11 MEASUREMENT OF CURRENT WAVE SHAPE

M-2. The harmonic components in the mains current shall be determined by means of a wave-analyser and the resistor R_1 introduced in the circuit shall be in accordance with Appendix E.

M-2.1 The peak value of the lamp current shall be determined by means of a calibrated cathode-ray oscilloscope and the resistor R_2 shall be inserted in the earthed side of the circuit.

M-2.2 The wave-analyser or the oscilloscope shall be connected with their earth connections on the supply side. During each of the two measurements, the resistor not in use is short-circuited and the apparatus not in use is disconnected.

M-2.3 The capacitor commonly included across the starting switch is replaced by a capacitor *C* of which the value is 0·01 μF.

M-2.4 Care shall be taken to ensure a sufficiently low impedance of the supply for the different frequencies involved.

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5-8-56C, L.N. Gupta Marg, Nampally Station Road, HYDERABAD 500001	320 10 84
E-52, Chitaranjan Marg, C- Scheme, JAIPUR 302001	37 38 79
117/418 B, Sarvodaya Nagar, KANPUR 208005	21 68 76
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TO

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PART 1 FOR SWITCH START CIRCUITS

(Second Revision)

[*Page 12, clause 9.1.4*(p) *and* (q)] - Substitute the following for the existing matter:

'p) Testing of performance (*see* 9.13), and

q) Resistance to corrosion (*see* 9.12)'.

(*Page 15, clause 9.7.3.4*) - Add the following sentence at the end of this clause:

'Immediately after the insulation resistance (humid) test, the ballast shall, in addition, withstand high voltage test mentioned in 9.7.4.'

(*Page 15, clause 9.7.4*) - Delete first sentence.

(*Page 15, clauses 9.7.5, 9.7.5.1 and 9.7.5.2*) - Substitute the following for the existing clauses:

'9.7.5 *Inter-Turn Insulation* - Ballasts shall have adequate inter-turn insulation.

Compliance is checked by submitting the windings for 1 min to a voltage equal to five times the voltage occurring in normal use and steady state, at not less than five times the rated frequency; the test voltage shall not, however, exceed the value specified in Table 3.

During the test, there shall be no short circuit between turns.

This requirement shall not apply to ballasts which are marked with a rated maximum operating temperature tw according to 9.8.'

(ETDC 23)

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PART 1 FOR SWITCH START CIRCUITS
(*Second Revision*)

[*Page* 12, *clause* **9.1.4**(q)] — Insert the following new item at the end:

'r) Test for ballast losses (*see* **9.14**).'

(*Page* 13, *clause* **9.2**) — Insert the following new item at the end:

'f) Test for ballast losses (*see* **9.14**).'

(*Page* 17, *clause* **9.9.5**) — Insert the following note at the end:

'NOTE — Test for limitations of ballast heating may be carried out after testing of performance.'

(*Page* 24, *clause* **9.13.9**) — Insert the following new clause:

'9.14 Test for Ballast Losses

9.14.1 The following method shall be used for the determination of the electrical energy consumed by ballast (ballast losses) in switch start circuits. The test shall be carried out by the following method:

a) Stabilize a reference lamp with a ballast for 15 minutes at 25 ± 2°C.

b) After stabilization period, switchover to test ballast.

c) Immediately measure (within 30 seconds) input power, power to lamp and current.

The ballast loss shall be calculated as follows:

Ballast losses $= (W_1 - W_L) - I^2 R_1 + I^2_R R_1$

where

W_1 = input power,

W_L = power to lamp,

I = running current measured within 30 seconds of switching on the test ballast in the circuit, and

I_R = nominal running current for lamps [*see* IS 2418 (Part 2) : 1977] Specification for tubular fluorescent lamps for general lighting service : Part 2 Standard lamp data sheets (*first revision*), and

R_1 = cold resistance at 25 ±2°C.

The wattmeter used for the measurement shall be of unity PF and shall be able to measure 0·2 W or better.

NOTE — This method of determination of ballast loss approximates the difference between total input power and lamp power when the ballast is operating at normal lamp current. It is considered that this method of measurement provides repeatable results with acceptable accuracy.

9.14.2 The maximum limits for ballast losses shall not exceed the following:

Ballast Wattage	*Maximum Permissible Loss in Watts*
20 W	12
40 W	12
65 W	16
80 W	20

NOTE — The above limits are the maximum permissible limits. The manufacturer may however, declare a lower limit for his ballasts. In such a case the loss in ballast shall not exceed the declared value by more than 10 percent.'

(ETDC 23)

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TO
IS 1534 (Part 1) : 1977 SPECIFICATION FOR BALLASTS FOR FLUORESCENT LAMPS

PART 1 FOR SWITCH START CIRCUITS

(Second Revision)

(*Page* 44, *clause* K-1.3) — Substitute the following for the existing clause:

'**K-1.3** When measuring the lamp wattage, the digital wattmeter of class 0.5 should be used. If analog wattmeter is used then due. Correction due to pressure/current coils should be applied.'

(*Page* 44, *clause* K-1.3, *Note*) — Delete the Note.

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PART 1 FOR SWITCH START CIRCUITS

(Second Revision)

(*Page* 45, *Appendix* M, *clause* M-2) — Insert the following Note at the end:

'NOTE — The value of the resistance R_1 shall be 1 ohm ± 0.2 ohm.'

(*Page* 45, *Appendix* M, *clause* M-2.1) — Insert the following Note at the end:

'NOTE — The value of the resistance R_2 shall be 1 ohm ± 0.2 ohm.'

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TO
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PART 1 FOR SWITCH START CIRCUITS

(Second Revision)

(*Page* 7, *clause* **3.1.5**) — Insert the following new clause after 3.1.5:

"**3.1.6** The material used for stamping shall conform to IS 648 : 1996 'Specification for non-oriented electrical steel sheets and strips for magnetic circuits (*fourth revision*)'."

[*Page* 10, *clause* **8.1** (j)] — Insert the following new entry after (j): :

'k) Ballast power loss .'

[*Page* 24, *clause* **9.14.2** (*see also Amendment No.* 2)] — Substitute the following for the existing clause:

'**9.14.2** The maximum limit for ballast losses shall not exceed the following:

Ballast Wattage	*Maximum Permissible Loss in Watts*
20 W	9
40 W	9
65 W	12
80 W	16

NOTE — The above limits are the maximum permissible limits. The manufacturers may however, declare a lower limit for his ballast. In such a case the loss in ballast shall not exceed the declared value by more than 10 percent.'

(ET 23)

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